

Sm-Nd and Sr isotope fingerprinting of iron mining tailing deposits from the failed SAMARCO Fundão dam 2015 accident at Mariana, SE-Brazil

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This work presents the first Sm-Nd and Sr isotope data on the fine-grained fraction (< 74 µm) of iron-rich deposits related to the November 5th, 2015 Mariana accident, caused by the rupture of the Fundão dam, an iron tailings pond operated by SAMARCO Mining, a BHP Billiton and Vale joint venture. The failure of the Fundão dam produced what is considered the most serious environmental accident in Brazil, with the sudden gravitational flow of approximately 62 Mi m³ of a quartz and iron oxide-rich slurry composed of water, fine sand and silt, that flowed into the Gualaxo do Norte and Carmo rivers, and eventually along the whole Doce river. At first, the mudflow caused the loss of 19 human lives and the total destruction of the Bento Rodrigues village, located ca.7 km downstream. The displacement of water created a propagating flood wave that was followed by a turbidity front that travelled for 673 km along the Rio Doce river, eventually reaching the sea 16 days later, giving rise to a large sediment plume in the adjoining seawater.

Samples were collected between 5 and 80 km downstream from the Fundão Dam, along the Santarém creek and the Gualaxo do Norte and Carmo rivers. X-Ray Diffractometry analyses show that samples are > 90% composed of quartz and iron oxides (hematite, goethite and magnetite), with minor phyllosilicates (kaolinite and mica). Major and trace element contents also closely match those of the original Paleoproterozoic Cauê Formation banded iron formation ore. The five most proximal samples, collected between the Fundão Dam and Bento Rodrigues village, yielded εNd between -17.0 and -19.7, similarly to those of the samples collected more downstream along the Gualaxo River, between -17.1 and -20.2. Neodymium model ages (T_{DM}) are between 1.94 Ga and 2.40 Ga. The most distal sample, collected at the Carmo River just downstream from the confluence with the Gualaxo River, shows more negative εNd of -23.2, and older TDM of 2.75 Ga. This contrasting value suggests a larger degree of mixing with incoming sediment derived from Archean terrain, brought by the Carmo River. Strontium ⁸⁷Sr/⁸⁶Sr ratios show variability between 0.7351 and 0.7729.

The reported Sm-Nd and Sr isotope compositions closely match those of the original iron ore, and contrast with those of upriver and downriver Precambrian to Ordovician bedrock units. The firstly defined isotope signature can thus be potentially used as a proxy for ongoing suspended sediment dispersion studies farther downstream along the Doce river and in adjacent marine environment.